Water Management at the Closed Brenda Mine – Reviewing a Decade of Performance

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OVERVIEW

1. Background, Site History and Key Features
2. Open Pit
3. Rock Stockpiles
4. Plant Site
5. Tailings Impoundment
6. Water Management
7. Summary and Conclusions
Brenda Mine Site

Copper / Molybdenum mine
Located 35 km west of Kelowna
Elevation = 1,500 meters
Footprint of 1300 ha
Operated from 1970 to 1990
20 ➔ 30 kt/day operation
182 Million tonnes of ore processed
Produced:
278,000 tonnes of Copper
66,000 tonnes of Molybdenum
Brenda – Overview
Brenda – Open Pit

- 1050 m x 980 m
- maximum depth of 370 m
- Current operating water depth is approx. 160 m or about 33 m below lowest point of pit rim
- Current water storage of about 35 Mm$^3$ with 52 Mm$^3$ capacity
Brenda – Open Pit
Brenda – Rock Stockpiles

- Four rock piles (N, NE, E and S)
- Approx. 109 Mt
- Built in 20 m lifts
- Stable and suitable for wildlife habitat
Brenda – Rock Stockpiles

East Pile

South Pile

North East Pile

North Pile
Brenda – Tailings Impoundment

- Approx. 300 ha in area
- Located in former McDonald Creek valley
- Consists of:
  - Main dam – crest is 2 km long
  - Tailings pond
  - Water pumping systems
  - Saddle dam
  - Upper reclaim pond and dam
  - Lower reclaim pond and dam
Brenda – Tailings
Brenda – Tailing Impoundment
Brenda – Tailings

- Seepages through dams are contained and sent to the tailings pond to prevent release of untreated water to the environment.
- Seepage flow rates and quality are monitored.
Molybdenum as an Environmental Driver

- Mine rock and tailings are NON-PAG
- Metal leaching - Molybdenum (Mo) was primary concern
- Trepanier Creek used for irrigation near Peachland with municipal water intake
- Molybdenum concern for:
  - uptake in harvested plants
  - local wildlife – especially ruminants
- Less to no concern for fish
Drainage Quality from Rock Piles

Rock Pile Runoff @ Confusion Point
pH

1999 2001 2003 2005 2007

Dissolved Molybdenum (mg/L)


pH

Mo
Closure Plan – The Process

- Brenda finalized its decommissioning plan in 1993
  - Active consultation via two public committees
    - technical
    - local stakeholders
- Three options for water management considered
  1. Discharge site runoff to MacDonald and Trepanier Creeks without treatment and provide an alternative supply of water for users on Trepanier Creek (Irrigation).
  2. Discharge runoff directly to Okanagan Lake in a pipeline running along the MacDonald and Trepanier Creek.
  3. Seasonal treatment to reduce molybdenum content with seasonal discharge to MacDonald and Trepanier Creeks.
- Option 3 was selected and an effluent discharge permit was required.
Brenda – Water Management

- Tailings pond and open pit used for active storage of collected water
- Seepage waters collected, returned to tailings pond and treated seasonally before release
- 2 to 3 Mm³ treated annually

Lower reclaim pond looking up to main dam
Brenda – Water Management

- Average Influent Mo = 2.75 mg/L
- Treatment plant consistently discharges water with concentrations averaging 0.05 mg/L (much lower than permit level of 0.25 mg/L)
Brenda – Water Management

• Water treatment solids (sludge) stored in engineered impoundment in catchment with flow reporting to tailings pond
• Designed to dewater and drain in order to consolidate solids
• Sludge drainage water goes to tailings pond
• Impoundment can be increased in size as required over time and will remain within catchment of tailings pond
Brenda – Water Management

Treatment solids (sludge) in containment cells

All seepage reports to tailings pond

Dewatered treatment solids
Water Management

2011 Water Flows

- Lower Reclain Pond: 1,109,524 m³
- Upper Reclain Pond: 17,469 m³
- Tailings Pond: Inflow to tailings 2,551,202 m³, outflow 2,841,304 m³
- Open Pit: Inflow to pit 589,864 m³, outflow 191,864 m³
- Water treatment plant: 4,633 m³ treated water to Polishing Pond
- Discharged to MacDonald Creek: 3,028,535 m³

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Molybdenum in Treated Effluent

Permit Limit = 0.25 mg/L

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Iron in Effluent

Effluent Discharge (Station 22)
Total Iron

Total Iron (mg/L)

01/01/2007  01/07/2007  01/01/2008  01/07/2008  01/01/2009  01/07/2009  01/01/2010  01/07/2010  01/01/2011  01/07/2011  01/01/2012

22 [FE-T]  Permit Limit  Occasional Exceedance Limit

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Flow rates in Trepanier Creek

Trepanier Creek Flows

Flow (cubic metres per second)

Jan  Feb  Mar  April  May  June  July  Aug  Sept  Oct  Nov  Dec

0  20  40  60  80  100  120  140  160  180  200

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Effluent and Downstream Concentrations of Sodium

Trepanier Creek at District Intake (Station 7) and Effluent Discharge (Station 22)
Dissolved Sodium
2007 through 2011

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Molybdenum Downstream

Trepanier Creek at District Intake (Station 7)
Dissolved Molybdenum
2007 through 2011

- Dissolved Molybdenum
- PE-00263 Permit Limit

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Sulphate Downstream

Trepanier Creek at District Intake (Station 7)
Dissolved Sulphate
2007 through 2011

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Hardness Downstream

Trepanier Creek at District Intake (Station 7)
Hardness 2007 through 2011
Brenda – Wildlife

- Wildlife and vegetation study indicated no adverse effects resulting from molybdenum toxicity in resident deer population (Beak, 2000)
- Ongoing vegetation studies (Golder, 2007) indicate all metals in vegetation within acceptable levels
Brenda - Conclusions

• Water with elevated molybdenum concentrations is effectively managed and treated before release to environment
• Downstream environment shows no signs of adverse effects as demonstrated by two (2) consecutive studies representing more than five (5) years of operation